PATENT CLAIMS

1. Electrotherapy apparatus comprising a sensor for detecting periodically recurring signal peaks, in particular the R-R peaks of an electrocardiogram of a person, a processor for deriving from the time interval between said periodically recurring signal peaks a time delay corresponding to approximately the end of the T-wave, a trigger system initiated by an output signal of said processor or embodied within said processor for applying electrical stimulations to one or more active electrodes provided on the said person at a time related to the end of said time delay,
characterized in that
the processor is adapted to generate, in addition to an initial electrical stimulation to induce muscle contraction, a plurality of further electrical stimulation pulses with intervals between each of said further electrical stimulation pulses so that said further electrical stimulation pulses maintain said muscle contraction over a period extending from said initial electrical stimulation substantially up to a time just before a next expected R-peak.

2. Electrotherapy apparatus in accordance with claim 1,
characterized in that
the processor is adapted to make a determination for successive pairs of signal peaks received from said sensor of a value corresponding to the time interval between said successive pairs of signal peaks and thus to the said person's momentary heart rate.

3. Electrotherapy apparatus in accordance with claim 1 or claim 2,

characterized in that
said processor is adapted to generate said initial electrical stimulation at a time in the range from -5 % of the preceding R-R path length, or of an average value of the preceding R-R path lengths, before the expected end of the T-wave and 45 % of the preceding R-R path length, or of an average value of the preceding R-R path lengths, after the expected end of the T-wave.

4. Electrotherapy apparatus in accordance with one of the preceding claims,
characterized in that
the initial electrical stimulation pulse comprises a plurality of preferably biphasic signal pulses having a first pulse repetition frequency and in that at least the majority of said further stimulating pulses are generated at intervals longer than an interval between the pulses of the initial electrical stimulation, i.e. at a second pulse repetition frequency lower than said first pulse repetition frequency.

5. Electrotherapy apparatus in accordance with claim 4,
characterized in that
the initial electrical stimulation pulse comprises from 2 to 10 individual pulses having a first pulse repetition frequency in the range from 50 to 250 Hz, preferably in the range from 100 to 200 Hz and especially of 150 Hz.

6. Electrotherapy apparatus in accordance with claim 4 or claim 5,
characterized in that
said second pulse repetition frequency for said further pulses lies in the range from 20 to 80 Hz, preferably in the range from 30 to 50 Hz, and especially of 40 Hz.

7. Electrotherapy apparatus in accordance with one of the preceding claims,
characterized in that
the pulses of said initial electrical stimulation have a pulse width lower than a pulse interval between said pulses.

8. Electrotherapy apparatus in accordance with claim 7,
characterized in that
said pulses of said initial electrical stimulation have a pulse width of the order of magnitude of 1 ms and the intervals between the said pulses have a duration of the order of magnitude of 3 to 10 ms, preferably 5 to 6 ms.

9. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
said further stimulating pulses are single biphasic pulses.

10. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
the pulse interval between said further electrical stimulation pulses lies in the range from 15 to 45 ms and is preferably 20 to 30 ms and especially ca. 25 ms.

11. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that

the interval between said further electrical stimulation pulses is selected to be greater than an interval between a signal being initiated at said sensor by a new R-peak and the time delay until this signal has been processed by said processor.

12. Electrotherapy apparatus in accordance with any one of the preceding claims, wherein said processor is adapted to terminate said further electrical stimulation pulses at a time such that said muscle contraction finishes in a calculated window of 85% to 95% of the preceding R-R path length, or of an average value of the preceding R-R path length, after the last R-peak.

13. Electrotherapy apparatus in accordance with claim 12, characterized in that
the processor is adapted to terminate said further electrical stimulation pulses at a time in the range from 70 to 90 % of the preceding R-R path length, or of an average value of the preceding R-R path length, after the last detected R-peak.

14. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
on detection of a next R-peak earlier than the expected time corresponding to the preceding R-R path length since the last R-pulse, or corresponding to an average value of the preceding R-R path lengths since the last R-pulse, the processor is adapted to inhibit any further electrical stimulation pulse until a time after the projected end of the T-wave in a subsequent heart cycle.

15. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
the processor is adapted to vary the pulse repetition frequency of the initial electrical stimulation in accordance with a predetermined pattern or randomly within a specified frequency range.

16. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
the processor is adapted to vary the pulse repetition frequency of the further electrical stimulation pulses in accordance with a predetermined pattern or randomly within a specified frequency range.

17. Electrotherapy apparatus in accordance with any one of the preceding claims, wherein said processor is adapted to vary an amplitude of pulses comprising said initial electrical stimulation and/or of said further pulses in accordance with a predefined pattern or randomly within a pre-specified range.

18. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
the processor is adapted to vary the shape of pulses comprising said initial electrical stimulation and of said further pulses.

19. Electrotherapy apparatus in accordance with any one of the preceding claims, wherein said sensor comprises an electrocardiograph and said processor is provided with a gating program to inhibit recognition of supposed R-peaks from said electrocardiograph in time

intervals corresponding to the transmission of said initial electrical stimulation and of said further pulses.

20. Electrotherapy apparatus in accordance with any one of the preceding claims 1 to 18,
characterized in that
said sensor is a non-electric sensor, or a non-electric sensor used in addition to an electrocardiograph.

21. Electrotherapy apparatus in accordance with claim 20,
characterized in that
said non-electric sensor is selected from the group comprising a non-invasive, aortic pressure measurement device, an invasive aortic pressure measurement device and a noise detection device adapted to detect the closing of the heart valves.

22. Electrotherapy apparatus in accordance with any one of the preceding claims,
characterized in that
the apparatus has a plurality of output channels for applying electrical stimulations to a plurality of active electrodes provided on the said person.

23. Electrotherapy apparatus in accordance with claim 22,
characterized in that a plurality (Y) of channel groups (A, B; A, B, C) is provided, each channel group (A, B; A, B, C) comprising a plurality of channels.

24. Electrotherapy apparatus in accordance with claim 23,

characterized in that each channel group (A, B; A, B, C) has the same number of channels (Ch.1, Ch. 2, Ch. 3, Ch.4 (Group A); Ch. 5, Ch. 6, Ch. 7, Ch. 8 (Group B); Ch. 9, Ch. 10, Ch. 11, Ch. 12 (Group C)).

25. Electrotherapy apparatus in accordance with claim 24, characterized in that means are provided for providing each channel group (A, B; A, B, C) with the same time delay.

26. Electrotherapy apparatus in accordance with claim 24, characterized in that means are provided for providing each channel group (A, B; A, B, C) with a respective time delay generally different from time delays associated with other channel groups.

27. Electrotherapy apparatus in accordance with claim 26, characterized in that the processor is adapted to provide a said time delay for one group of channels (A) and to add a respective time off-set to said time delay for each further channel group (B; B, C).

28. A method of treating a person or a mammal, in particular using electrotherapy apparatus in accordance with any one of the preceding claims, the method comprising the steps of:

- determining from the signal peaks of an electrocardiogram for at least a majority of the detected heart cycles a time corresponding to the distance between successive pairs of R-R peaks,

- generating an initial electrical stimulation signal,

- applying said initial electrical stimulation signal to a muscle or group of muscles of said person or mammal at a time related to the predicted end of the T-wave and lying in the range from -5 % of the R-R path length of the preceding heart cycle, or of an average preceding R-R path length, before the predicted end of the T-wave, up to +45 % of the preceding R-R path length of the preceding heart cycle, or of an average preceding R-R path length, after the end of the T-wave to generate a muscle contraction, characterized by the further step of

- applying further electrical stimulation pulses to said muscle or group of muscles to maintain said contraction for a time after the last detected R-peak corresponding to 85 to 95 % of the R-R path length of the preceding heart cycle or of an average preceding R-R path length.

29. A method in accordance with claim 28, wherein the step of applying further electrical stimulation pulses to said muscle or group of muscles to maintain said contraction comprises applying further stimulating pulses to said muscle or group of muscles at intervals longer than an interval between pulses of the initial electrical stimulation, i.e. at a second pulse repetition frequency lower than a first pulse repetition frequency of the initial electrical stimulation.

30. Method in accordance with claim 29,
characterized in that
the initial electrical stimulation pulse comprises from 2 to 10 individual pulses having a first pulse repetition frequency in the range from 50 to 250 Hz, preferably in the range from 100 to 200 Hz and especially of 150 Hz.

31. Method in accordance with claim 29 or claim 30,
characterized in that
said second pulse repetition frequency for said further pulses lies in the range from 20 to 80 Hz, preferably in the range from 30 to 50 Hz, and especially of 40 Hz.

32. Method in accordance with one of the preceding claims 28 to 31,
characterized in that
the pulses of said initial electrical stimulation have a pulse width lower than a pulse interval between said pulses.

33. Method in accordance with claim 32,
characterized in that
said pulses of said initial electrical stimulation have a pulse width of the order of magnitude of 1 ms and the intervals between the said pulses have a duration of the order of magnitude of 3 to 10 ms, preferably 5 to 6 ms.

34. Method in accordance with any one of the preceding claims 28 to 33,
characterized in that
said further stimulating pulses are single biphasic pulses.

35. Method in accordance with any one of the preceding claims 28 to 34,
characterized in that
the pulse interval between said further electrical stimulation pulses lies in the range from 15 to 45 ms and is preferably 20 to 30 ms and especially ca. 25 ms.

36. Method in accordance with any one of the preceding claims 28 to 35,
characterized in that
the interval between said further electrical stimulation pulses is selected to be greater than a time delay associated with a signal being initiated at said sensor by an R-peak and the time delay until this signal has been processed by said processor.

37. Method in accordance with any one of the preceding claims 28 to 36, wherein said processor terminates said further electrical stimulation pulses at a time such that said muscle contraction finishes in a calculated window of 85% to 95% of the preceding R-R path lengths, or of an average value of the preceding R-R path lengths, after the last R-peak.

38. Method in accordance with claim 37,
characterized in that
the processor is adapted to terminate said further electrical stimulation pulses at a time in the range from 70 to 90 % of the preceding R-R path length, or of an average value of the preceding R-R path lengths, after the last detected R-peak.

39. Method in accordance with one of the preceding claims 28 to 38,
characterized in that
on detection of a next R-peak earlier than the expected time corresponding to the preceding R-R path length since the last R-pulse, or corresponding to an average value of the preceding R-R path lengths since the last R-pulse, the processor is adapted to inhibit any further electrical stimulation pulse until a time after the projected end of the T-wave in a subsequent heart cycle.

40. Method in accordance with any one of the preceding claims 28 to 37,
characterized in that
the pulse repetition frequency of the initial electrical stimulation can be varied by said processor in accordance with a predetermined pattern or randomly within a specified frequency range.

41. Method in accordance with any one of the preceding claims 28 to 40,
characterized in that
the pulse repetition frequency of the further electrical stimulation pulses is varied by said processor in accordance with a predetermined pattern or randomly within a specified frequency range.

42. Method in accordance with any one of the preceding claims 28 to 41, wherein said processor varies an amplitude of pulses comprising said initial electrical stimulation and/or of said further pulses in accordance with a predefined pattern or randomly within a prespecified range.

43. Method in accordance with any one of the preceding claims 28 to 42,
characterized in that
the processor varies the shape of pulses comprising said initial electrical stimulation and of said further pulses.

44. Method in accordance with any one of the preceding claims 28 to 43,
characterized in that

the apparatus has a plurality of output channels for applying electrical stimulations to a plurality of active electrodes provided on the said person and in that, in a first heart cycle, a first output channel delivers electrical stimulation signals to a first electrode, and, in a second heart cycle, a second output channel delivers electrical stimulation signals to a second active electrode and so on until a last output channel delivers electrical stimulation signals to a last active electrode, whereupon the cycle repeats with the first output channel delivering electrical stimulation signals to said first active electrode etc.

45. A method of treating a person or a mammal using electrotherapy apparatus in accordance with any one of claims 28 to 44, wherein a plurality (Y) of channel groups (A, B; A, B, C) is provided, each channel group (A, B; A, B, C) comprising a plurality of channels. characterized in that
each channel group of output channels is associated with a respective group of muscles in general proximity to one another on a body of said person or mammal, in that the group of muscles associated with one group of output channels differs from a group of muscles associated with any other group of output channels, and in that the stimulation signals transmitted from each group of output channels to the respectively associated group of muscles are triggered at the same time for each group of channels.

46. A method of treating a person or a mammal using electrotherapy apparatus in accordance with any one of claims 28 to 44, wherein a plurality (Y) of channel groups (A, B; A, B, C) is provided, each channel group (A, B; A, B, C) comprising a plurality of channels, characterized in that

each channel group of output channels is associated with a respective group of muscles in general proximity to one another on a body of said person or mammal, in that a group of muscles associated with one group of output channels differs from a group of muscles associated with any other group of output channels, and in that the stimulation signals transmitted from each group of output channels to the respectively associated group of muscles are triggered at different times for each group of channels.

47. A method in accordance with claim 46,
characterized in that
the groups of muscles respectively associated with each group of channels are disposed on a body of said person or mammal such that a group of muscles closer to the heart and associated with one group of channels is stimulated later than a group of muscles disposed further from the heart and associated with another group of channels.

48. A method in accordance with claim 46,
characterized in that
the groups of muscles respectively associated with each group of channels are disposed on a body of said person or mammal such that a group of muscles further from the heart and associated with one group of channels is stimulated later than a group of muscles disposed closer to the heart and associated with another group of channels.

49. Electrotherapy apparatus comprising a sensor for detecting periodically recurring signal peaks, e.g. the R-R peaks of an electrocardiogram of a person, a processor for deriving from the time interval be-

tween said periodically recurring signal peaks a time delay corresponding to approximately the end of the T-wave, a trigger system initiated by an output signal of said processor or embodied within said processor for applying electrical stimulations to one or more active electrodes provided on the said person at a time related to the end of said time delay,
characterized in that
the processor is adapted to generate, in addition to an initial electrical stimulation to induce muscle contraction, at least one further electrical stimulation pulse with an interval between said at least one further electrical stimulation pulse and said initial electrical stimulation or intervals between said further electrical stimulation pulses, so that said further electrical stimulation pulse or pulses maintain said muscle contraction over a period extending from said initial electrical stimulation substantially up to a time just before a next expected R-peak.

50. An electrotherapy apparatus in accordance with claim 1, wherein said further electrical stimulation pulses each comprise a train of pulses, the pulses of each train being separated by an interval or following one another directly, thereby defining a duration of each train.

51. An electrotherapy apparatus in accordance with claim 50, characterized in that
intervals are present between the initial electrical stimulation and the first train and between sequential trains.

52. An electrotherapy apparatus in accordance with either one of claims 50 or 51,

characterized in that
the pulses in any train can have amplitudes of any desired level and different amplitudes within the same train and/or the duration of each train can be different from the duration of any other train and/or the pulse repetition frequency of the pulses in any one train can be different and can differ from train to train.